

CLAIMS

What is claimed is:

1. A processable rubber composition comprising a cured fluorocarbon elastomer dispersed in a matrix comprising a thermoplastic material, wherein:

the thermoplastic material comprises a fully fluorinated thermoplastic polymer and a partially fluorinated thermoplastic polymer; and

the cured fluorocarbon elastomer is present at a level of greater than or equal to 35% by weight based on the total weight of cured fluorocarbon elastomer and thermoplastic material.
2. A composition according to Claim 1, wherein the cured fluorocarbon elastomer is present at a level of greater than or equal to 50% by weight.
3. A composition according to Claim 1, wherein the composition exhibits a single melting temperature of less than 305°C.
4. A composition according to Claim 3, wherein the composition exhibits a single melting temperature of less than 290°C.
5. A composition according to Claim 4, wherein the composition exhibits a single melting temperature of less than 250°C.

6. A composition according to Claim 1, wherein the thermoplastic material comprises more than 60 wt % fluorine.
7. A composition according to Claim 1, wherein the thermoplastic material comprises 10-90% by weight of the fully fluorinated polymer.
8. A composition according to Claim 1, wherein the ratio of the weight of the fully fluorinated polymer to the weight of the partially fluorinated polymer in the matrix ranges from 1:9 to 9:1.
9. A composition according to Claim 8, wherein the ratio of the weight of the fully fluorinated polymer to the weight of the partially fluorinated polymer in the matrix ranges from 1:2 to 2:1.
10. A method according to Claim 1, wherein the fluorocarbon elastomer comprises repeating units derived from vinylidene fluoride and hexafluoropropylene.
11. A method according to Claim 10, wherein the fluorocarbon elastomer further comprises repeating units derived from tetrafluoroethylene.

12. A method according to Claim 1, wherein the fluorocarbon elastomer is selected from the group consisting of: VDF/HFP, VDF/HFP/TFE, VDF/PFVE/TFE, TFE/Pr, TFE/Pr/VDF, TFE/Et/PFVE/VDF, TFE/Et/PFVE, TFE/PFVE, and mixtures thereof.
13. A method according to Claim 12, wherein the fluorocarbon elastomer also comprises cure site monomers.
14. A method according to Claim 1, wherein the thermoplastic material comprises a fully fluorinated polymer selected from the group consisting of PFA, MFA and FEP, and a partially fluorinated polymer selected from the group consisting of polyvinylidene fluoride and copolymers of vinylidene fluoride.
15. A processable rubber composition comprising a cured fluorocarbon elastomer dispersed in a thermoplastic matrix, wherein
the thermoplastic matrix comprises a fully fluorinated thermoplastic polymer and a partially fluorinated thermoplastic polymer;
the cured fluorocarbon elastomer is present as a discrete phase or a phase co-continuous with the matrix; and
the dimensions of the elastomer phase are less than 10 μm , as measured by atomic force microscopy on cryogenically microtomed cross-sections of shaped articles formed from the processable rubber composition.

16. A composition according to Claim 15, wherein the dimensions of the elastomer phase are less than or equal to 1 μm .
17. A composition according to Claim 15, wherein the cured fluorocarbon elastomer is present at least in part as particles dispersed in a continuous thermoplastic phase.
18. A composition according to Claim 15, wherein the cured fluorocarbon elastomer is present at least in part in a dispersed phase co-continuous with the thermoplastic phase.
19. A composition according to Claim 15, wherein the composition exhibits a single melting temperature of less than 290°C.
20. A composition according to Claim 15, wherein the composition exhibits a single melting temperature of less than 250°C.
21. A composition according to Claim 15, wherein the ratio of the weight of the fully fluorinated polymer to the weight of the partially fluorinated polymer in the matrix ranges from 1:9 to 9:1.
22. A composition according to Claim 21, wherein the ratio of the weight of the fully fluorinated polymer to the weight of the partially fluorinated polymer in the matrix ranges from 1:2 to 2:1.

23. A method for making a processable rubber composition comprising:
mixing an elastomeric component and a thermoplastic component in the presence of
a curative agent, and
heating during mixing to effect cure of the elastomeric component.
wherein the elastomeric material comprises a fluorocarbon elastomer; and
wherein the thermoplastic material is a fluoroplastic blend comprising a fully
fluorinated thermoplastic polymer and a partially fluorinated thermoplastic
polymer.
24. A method according to Claim 23, comprising
forming a mixture by combining the curative, an uncured or partially cured
elastomeric material, and the thermoplastic material; and
heating the mixture at a temperature and for a time sufficient to effect vulcanization
of the elastomeric material, wherein mechanical energy is applied to mix the
mixture during the heating step.
25. A method according to Claim 23 comprising:
mixing the elastomeric material and the thermoplastic material for a time and at a
shear rate sufficient to form a dispersion of the elastomeric material in a continuous
thermoplastic phase;
adding a curative to the dispersion while continuing the mixing; and
heating the dispersion while continuing to mix the curative, elastomeric material,
and thermoplastic material.

26. A method according to Claim 23, wherein the ratio of the weight of the fully fluorinated polymer to the weight of the partially fluorinated polymer in the matrix ranges from 1:9 to 9:1.
27. A method according to Claim 26, wherein the ratio of the weight of the fully fluorinated polymer to the weight of the partially fluorinated polymer in the matrix ranges from 1:2 to 2:1.
28. A method according to Claim 23, wherein the fluorocarbon elastomer comprises repeating units derived from vinylidene fluoride and hexafluoropropylene.
29. A method according to Claim 28, wherein the fluorocarbon elastomer further comprises repeating units derived from tetrafluoroethylene.
30. A method according to Claim 23, wherein the fluorocarbon elastomer is selected from the group consisting of: VDF/HFP, VDF/HFP/TFE, VDF/PFVE/TFE, TFE/Pr, TFE/Pr/VDF, TFE/Et/PFVE/VDF, TFE/Et/PFVE, TFE/PFVE, and mixtures thereof.
31. A method according to Claim 30, wherein the fluorocarbon elastomer also comprises cure site monomers.
32. A method according to Claim 23, wherein the curative comprises a polyol.

33. A method according to Claim 23, wherein the curative comprises a peroxide.
34. A method according to Claim 23, wherein the thermoplastic material comprises a fully fluorinated polymer selected from the group consisting of PFA, MFA and FEP, and a partially fluorinated polymer selected from the group consisting of polyvinylidene fluoride and copolymers of vinylidene fluoride.
35. A method according to Claim 23, comprising a continuous process.
36. A method according to Claim 35, carried out in a twin screw extruder.
37. A method according to Claim 23, comprising a batch process.
38. A method according to Claim 23, wherein the composition comprises at least about 35 parts by weight vulcanized elastomeric material per 100 parts of the vulcanized elastomeric material and thermoplastic material combined.
39. A method according to Claim 23, wherein the combination comprises at least about 50 parts by weight vulcanized elastomeric material per 100 parts of the vulcanized elastomeric material and thermoplastic material combined.

40. A shaped article comprising a cured fluorocarbon elastomer dispersed in a matrix comprising a thermoplastic material, wherein the thermoplastic material comprises from about 10 to about 90% by weight of a fully fluorinated thermoplastic polymer and from about 10 to about 90% by weight of a partially fluorinated thermoplastic polymer.
41. A shaped article according to Claim 40, wherein the hardness of the article is Shore A 50 or greater, the tensile strength of the article is 4 MPa or greater, the modulus at 100% of the article is 4 MPa or greater, or the elongation at break of the article is 10% or greater.
42. A shaped article according to Claim 40, wherein the cured fluorocarbon elastomer is present at a level of at least 35% by weight based on the total weight of cured fluorocarbon elastomer and thermoplastic polymer.
43. A shaped article according to Claim 40 wherein the cured fluorocarbon elastomer is present at a level of at least 50% by weight based on the total weight of cured fluorocarbon elastomer and thermoplastic polymer.
44. A method according to Claim 40, wherein the fluorocarbon elastomer is selected from the group consisting of: VDF/HFP, VDF/HFP/TFE, VDF/PFVE/TFE, TFE/Pr, TFE/Pr/VDF, TFE/Et/PFVE/VDF, TFE/Et/PFVE, TFE/PFVE, and mixtures thereof.

- 45. A seal according to Claim 40.
- 46. An O-ring according to Claim 40.
- 47. A gasket according to Claim 40.
- 48. A hose according to Claim 38.
- 49. A method for reducing costs of a manufacturing process for making shaped rubber articles from a processable rubber composition, comprising recycling scrap material generated during the manufacturing process to make new shaped articles comprising the processable rubber composition, wherein the processable rubber composition is the product of dynamic vulcanization of a fluorocarbon elastomer in the presence of a thermoplastic material, wherein the thermoplastic material comprises from about 10 to about 90% by weight of a fully fluorinated thermoplastic polymer and from about 10 to about 90% by weight of a partially fluorinated thermoplastic polymer.
- 50. A method according to Claim 49, wherein the manufacturing process comprises forming the shaped articles by a thermoplastic processing technique.

51. A method according to Claim 49, wherein the thermoplastic processing technique is selected from the group consisting of blow molding, injection molding, compression molding, and extrusion.
52. A method according to Claim 49, wherein recycling comprises melting the scrap material at a temperature below the melting point of the fully fluorinated polymer.
53. A method according to Claim 49, wherein recycling comprising melting the scrap material at a temperature below 250°C.
54. A process of manufacturing shaped plastic articles, comprising
preparing a processable rubber composition by dynamically vulcanizing a fluorocarbon elastomer in the presence of a fluoroplastic blend comprising a fully fluorinated polymer and a partially fluorinated polymer;
melting the rubber composition; and
fabricating the shaped article from the molten rubber composition with a thermoplastic processing technique.
55. A method according to Claim 54, comprising melting the rubber at a temperature below the melting temperature of the fully fluorinated polymer.

- 56. A method according to Claim 54, comprising melting the rubber at a temperature below 280°C, wherein the fluoroplastic blend comprises more than 65% by weight fluorine.
- 57. A method according to Claim 54, comprising injection molding the molten rubber composition.
- 58. A method according to Claim 54, comprising extruding the molten rubber composition.